BRISTOL BAY SOCKEYE SALMON SPAWNING ESCAPEMENT TEST FISHING, 1999

by

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ABSTRACT

Drift gillnets were fished daily at two stations, located on opposite river banks, prior to every high slack tide in Kvichak, Egegik, Ugashik, and Igushik Rivers, Bristol Bay, Alaska, from mid-June to mid-July to estimate sockeye salmon spawning escapements. Preliminary estimates were used by fishery managers as an inseason management tool to regulate commercial harvests and achieve escapement goals. The daily test fish index for each river was the mean of catch per unit effort values obtained from all test drifts made on a given day. Numbers of sockeye salmon that escaped the commercial fishery were estimated using (1) travel time analysis in which the most recent cumulative tower count was divided by cumulative test fish indices and lagged back in time by daily increments, and (2) the mean escapement per index point (EPI) value. Mean EPI estimates were available on the first day of each project. Travel time estimates could not be made until a minimum of test fishing data and tower counts were collected.

KEY WORDS: Sockeye salmon *Onchorhynchus nerka,* test fishing, spawning escapement estimation, estimation, fisheries management, Bristol Bay

INTRODUCTION

River test fishing conducted by the Alaska Department of Fish and Game (ADF&G) is used to estimate numbers of salmon that have escaped commercial fishing districts and entered their natal streams. In Bristol Bay, river test fisheries are used to manage sockeye salmon *Onchorhynchus nerka* fisheries (Figure 1). Test-fishery data are available approximately 1 d after sockeye salmon have passed through the commercial fishing district and several days earlier than estimates based on visual counts from observation towers located at the heads of the river systems. Spawning escapement estimates based on test-fish data assist management biologists in regulating commercial fishing periods to maximize harvests and achieve escapement goals. Test-fishing projects have been operated on Kvichak River since 1960, on Egegik River since 1963, on Ugashik River since 1961, and on Igushik River since 1976 (McBride 1978; Paulus 1965). This report summarizes 1999 test-fish data and evaluates the accuracy of forecasting methods used during these seasons.

METHODS

River Test Fishing

Two stations on opposite river banks were fished in the lower section of Kvichak, Egegik, Ugashik, and Igushik Rivers, 1999 (Table 1). Test-fish stations were close to the commercial fishing district boundary but above sockeye salmon milling areas. Stations fished at all four rivers have remained the same since 1987 (Fried and Bue 1988a).

Gillnets were drifted at all test-fish sites to estimate sockeye salmon abundance. All drifts were made perpendicular and close to shore because sockeye salmon migrate parallel to and near the river bank. Drifts at all stations were ended when the inshore end of the net drifted about 25 m offshore or when it was no longer fishing efficiently. Two short drifts of <15 min duration were made at each station of each river beginning about 1.5 h before every high slack tide for the entire season to minimize currents carrying the gillnet offshore. When catches increased to the point where two drifts per station per tide were no longer feasible, only one drift was made at each station until catches fell to a manageable level again.

All gillnets were 45.7 m (150 ft or 25 fathoms) in length and 29 meshes deep. Monotwist web, hung even with #50 twine and dyed Momoi shade #1, was used for test fishing on all rivers. Multistrand monofilament was used until 1989; however, this web type is now illegal for commercial use and is no longer stocked by suppliers. A stretched mesh size of 12.70 cm (5 in) was used on Kvichak River and 13.02 cm (5-1/8 in) was used on Egegik, Ugashik, and Igushik Rivers.

Catch per unit of effort (CPUE), or the number of sockeye salmon caught in 180 m (600 ft or 100 fathoms) of gillnet fished for 1 h, was estimated for each set. Water temperature (°C) was recorded at all rivers on every high tide prior to test fishing.

Data Analyses

Mean fishing time (MT), in minutes, was calculated for each set as

$$MT = SI - FO + \frac{(FO - SO) + (FI - SI)}{2}, \quad (1)$$

where:

SO = time the gillnet first entered water,

FO = time the gillnet was fully deployed,

SI = time the gillnet retrieval began, and

FI = time the gillnet retrieval completed.

The CPUE value, C_j, or the number of sockeye salmon caught per 100 fathom hours, was calculated for set *j* as follows:

$$C_j = 6{,}000 \frac{N}{G \times MT}, \quad (2.1)$$

where:

N = number of sockeye salmon caught, and

G = gillnet length in fathoms.

Then the daily test fish index, I_i, for day *i* was calculated as the mean of individual CPUE values obtained from sets made the same day, or

$$I_i = \frac{\sum_{j=1}^{s} C_j}{S}, \tag{2.2}$$

where

S = number of sets made during day i (usually four sets per day).

Two methods were used to estimate daily spawning escapements: (1) travel-time (EPI_d), and (2) mean EPI value (EPI_a).

Travel-time estimates of spawning escapements were based on the number of days it took sockeye salmon to travel from test fish sites to counting tower sites. A range of travel-time estimates was calculated by matching daily test-fish indices to daily tower counts. The number of sockeye salmon represented by each index point was calculated by dividing the most recent cumulative tower count by cumulative test-fish indices lagged back in time by daily increments such that

$$EPI_d = \frac{\sum_{i=1}^{t} E_i}{\sum_{i=1}^{t-d} I_i}, \tag{3}$$

where:

EPI_d = number of sockeye salmon represented by each test fishing index point based on a travel-time of d days,

E_i = number of sockeye salmon traveling past counting tower on day i, and

t = day of most recent escapement estimate.

The best initial estimate of travel time produced the smallest squared sum of errors between daily cumulative test-fish indices and tower counts. However, travel times that seemed unrealistic based on results of past studies or produced unreasonable escapement estimates (e.g., less than observed escapement) were rejected even if they produced the best statistical fit to the data.

Total spawning escapement was then estimated as

$$\hat{E}_{t+d} = EPI_d \sum_{i=1}^{t} I_i, \tag{4}$$

where
E_{t+d} = estimated number of sockeye salmon that will travel past counting tower on day $t+d$.

Three statistics were used to measure performance of the various escapement estimators. Percent error, PE, was used to measure daily performance:

$$PE = 100 \; x \; \frac{T_{t,a} - \sum_{i=1}^{t+d} E_i}{\sum_{i=1}^{t+d} E_i}, \tag{5}$$

where
$T_{t,a}$ = estimated cumulative spawning escapement on day t based on method a.

Mean percent error, MPE, was used to measure bias:

$$MPE = \sum_{t=1}^{n} \left(\frac{100 \, x \, T_{t,a} - \sum_{i=1}^{t+d} E_i}{\sum_{i=1}^{t+d} E_i} \right), \tag{6}$$

where
n = total number of days that escapement estimates based on test fishing were available

Mean absolute percent error, MAPE, was used to measure overall accuracy because it treated under- and over-estimation errors similarly:

$$MAPE = \sum_{t=1}^{n} \left| \left(100 \, x \, \frac{T_{t,a} - \sum_{i=1}^{t+d} E_i}{\frac{\sum_{i=1}^{t+d} E_i}{n}} \right) \right| \tag{7}$$

RESULTS

Kvichak River

Test fishing began 21 June and ended 16 July. A total of 5,784 sockeye salmon were caught, producing 73,725 index points (Table 2, Appendix A.1.). Test fish escapement estimates for 24 June to 5 July were based on the 1985-98 mean EPI value of 106 (Table 2, Appendix B.1.). Sufficient spawning escapement data were collected by 6 July to allow estimation of EPI values based on travel time (Table 2). Estimated travel times during the season ranged from 2 to 5 d. On the last day of project operation, the best estimate of travel time was 4 d and the EPI was 85 (Table 2, Appendix B.1.).

Daily escapement estimates based on the 1985-98 mean EPI (24 June to 5 July) ranged from 98% less to 2,082% greater than visual counts from towers, assuming actual travel time was 4 d (Table 2). Daily escapement estimates based on travel time analysis (6 – 16 July) ranged from 19% less to 8% greater than tower counts (Table 2, Figure 2). The travel time analysis estimate of 6,266,625 sockeye salmon on 16 July was 3% greater than the lagged cumulative tower count (20 July) of 6,109,500.

Accuracy (MAPE) and bias (MPE) for all test fish escapement estimates compared to lagged tower counts was 166% and 125% respectively (Table 2). When the comparison was restricted to travel time analysis only (6 to 15 July), accuracy and bias improved to 10% and -7% respectively.

Egegik River

Test fishing began 14 June and ended 13 July. A total of 3,307 sockeye salmon were caught producing a cumulative index of 20,568 (Table 3, Appendix A.2.). Test fish escapement estimates for 14 June to 6 July were based on the 1996-98 mean EPI value of 62 (Table 3, Appendix B.2.). Sufficient spawning escapement data were collected by 7 July to allow estimation of EPI values based on travel time (Table 3). Estimated travel times during this period ranged from 5 to 7 d. On the last day of project operation, the best estimate of travel time was 5 d and the EPI was 82 (Table 3, Appendix B.2.).

Daily escapement estimates based on the 1985-93 mean EPI (20 June to 6 July) ranged from 21% less to 64,349% greater than visual counts from towers, assuming actual travel time was 5 d (Table 3). Daily escapement estimates based on travel time analysis (7 to 13 July) ranged from 11% less to 2% less than tower counts (Table 3, Figure 3). The travel time analysis estimate of

1,686,576 sockeye salmon on 13 July was 2% less than the lagged cumulative tower count on 18 July of 1,727,772.

Accuracy (MAPE) and bias (MPE) for all test fish escapement estimates compared to lagged tower counts was 11,934% and 11,925% respectively (Table 3). When the comparison was restricted to travel time analysis only (7 to 13 July), accuracy and bias improved to 7% and -7% respectively.

Ugashik River

Test fishing began 24 June and ended 18 July. A total of 1,229 sockeye salmon were caught producing a cumulative index of 17,549 (Table 4, Appendix A.3.). Test fish escapement estimates for 24 June to 16 July were based on the 1985-98 mean EPI value of 54 (Table 4, Appendix B.3.). Sufficient spawning escapement data were collected by 17 July to allow estimation of EPI values based on travel time (Table 4). Estimated travel time during this period was 5 d. On the last day of project operation, the best estimate of travel time was 5 d and the EPI was 84 (Table 4, Appendix B.3.).

Daily escapement estimates based on the 1985-98 mean EPI (2 to 16 July) ranged from 40% less to 354% greater than visual counts from towers, assuming actual travel time was 5 d (Table 4). Daily escapement estimates based on travel time analysis (17 - 18 July) ranged from 8% less to 8% greater than tower counts (Table 4, Figure 4). The travel time analysis estimate of 1,474,116 sockeye salmon on 18 July was 8% less than the lagged cumulative tower count on 23 July of 1,606,242.

Accuracy (MAPE) and bias (MPE) for all test fish escapement estimates compared to lagged tower counts was 44% and 1% respectively (Table 4). When the comparison was restricted to travel time analysis only (17 – 18 July), accuracy and bias improved to 8% and -8% respectively.

Igushik River

Test fishing began 16 June and ended 8 July. A total of 1,936 sockeye salmon were caught producing a cumulative index of 16,994 (Table 5, Appendix A.4.). Test fish escapement estimates for 16 June – 2 July were based on the 1988-92, 1994-98 mean EPI value of 57 (Table 5, Appendix B.4.). Sufficient spawning escapement data were collected by 2 July to allow estimation of EPI values based on travel time (Table 5). Estimated travel times during this period ranged from 2 to 5 d. On the last day of project operation, the best estimate of travel time was 2 d and the EPI was 19 (Table 5, Appendix F.4.).

Daily escapement estimates based on the historic mean EPI (28 June to 2 July) ranged from 139% to 1,730% greater than visual counts from towers, assuming actual travel time was 2 d

(Table 5). Daily escapement estimates based on travel time analysis (3 to 8 July) ranged from 3% less to 74% greater than tower counts (Table 5, Figure 5). The travel time analysis estimate of 322,886 sockeye salmon on 8 July was 2% less than the lagged cumulative tower count on 10 July of 328,050.

Accuracy (MAPE) and bias (MPE) for all test fish escapement estimates compared to lagged tower counts was 215% and 214% respectively (Table 5). When the comparison was restricted to travel time analysis only (3 to 8 July), accuracy and bias improved to 24% and 23% respectively.

DISCUSSION

The Bristol Bay river test fish pre-season mean EPI's performed poorly on all rivers in 1999. The mean EPI values were high for Kvichak and Igushik rivers (Appendices B.1 and B.4.) and low for Egegik and Ugashik rivers (Appendices B.2. and B.3.). The difference was most exaggerated on Igushik River where the average EPI was 57 and the final EPI was 19 (Appendix B.4.).

Two factors in particular may have confounded the river test fish estimates: 1) longer than normal travel times between test fish and counting tower in Kvichak, Egegik, and Ugashik rivers and 2) a higher than normal percentage of 2-ocean fish in Egegik, and Ugashik rivers.

Travel times for sockeye salmon in Kvichak, Egegik, and Ugashik rivers were approximately twice as long as the most recent five-year average (Appendices B.1., B.2., and B.3.). When this occurs, pulses of fish observed at test fish are less pronounced at the counting tower, preventing an early and accurate lag-time relationship. One possible explanation for the lengthy travel time in Egegik River is the low water temperatures encountered because of a late break-up. Ice was flowing into Egegik River from Becharof Lake on June 15 and the water temperature in the river was 0°C (Crawford, 2000). The late break-up was not observed at either Kvichak or Ugashik rivers.

The small size of the fish in Egegik and Ugashik rivers in 1999 may have played a role in the poor performance of test fish escapement estimates. The percentage of 2-ocean sockeye salmon in the escapements of Egegik and Ugashik rivers (typically under 50%) was over 80% in 1999. Test fish catches in these rivers are typically dominated by larger 3-ocean fish, and for this reason, 5 1/8" mesh is used rather than 5" mesh (used in the Kvichak River). The river test fish crews at these rivers noticed a high incidence of fish passing through their 5 1/8" mesh gill nets evidenced by more "hits" on the net than entangled fish upon retrieval, small fish breaking the surface after fighting their way through the net, and fish entangled at the dorsal fin. The decreased catchability of the smaller 2-ocean fish would cause the test fishery to under estimate the escapement.

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Table 1. Locations (GPS coordinates) of Bristol Bay sockeye salmon test-fishing stations.

River	Test - Fishing Stations	River Bank	GPS Coordinates[1]
Kvichak River	1	West	N 59° 01' 16.3", W 156° 52' 34.4"
	2	East	N 59° 03' 25.3", W 156° 51' 10.0"
Egegik River	1	South	N 58° 12.04', W 157° 10.00'
	2	North	N 58° 11.97', W 157° 11.00'
Ugashik River	1	East	N 57° 33.262', W 157° 25.010'
	2	West	N 57° 33.419', W 157° 25.848'
Igushik River	1	South	N 58° 49.51', W 159° 02.36'
	2	North	N 58° 49.48', W 159° 02.36'

[1] GPS coordinates are generally considered to be accurate within 300 ft.

Table 2. Sockeye salmon spawning escapement test-fishing data summary and comparison to tower counts, Kvichak River, 1999.

	Test Fishing							Observation Tower		
Date	Fishing Time(min)	Catch (no)	Daily Index	Cumulative Index	Escapement per Index Pt.[1]	Cumulative Escapement	Estimated River Fish[3]	Date Plus Travel Time[2]	Cumulative Escapement	Percent Error of Test Fishing Estimate
6/21	81.3	0	0	0	106	0		6/25	54	
6/22	39.5	0	0	0	106	0		6/26	90	
6/23	80.9	0	0	0	106	0		6/27	180	
6/24	81.4	14	42	42	106	4,452	4,000	6/28	204	2,082
6/25	78.9	2	6	48	106	5,088	5,000	6/29	438	1,062
6/26	82.3	0	0	48	106	5,088	5,000	6/30	17,400	-71
6/27	68.7	1	4	52	106	5,512	5,000	7/01	104,850	-95
6/28	80.6	0	0	52	106	5,512	5,000	7/02	337,092	-98
6/29	70.7	298	1,322	1,374	106	145,644	150,000	7/03	748,320	-81
6/30	40.2	560	4,944	6,318	106	669,708	700,000	7/04	1,086,408	-38
7/01	18.0	653	11,383	17,701	106	1,876,306	1,800,000	7/05	1,523,532	23
7/02	23.4	378	4,095	21,796	106	2,310,376	2,000,000	7/06	1,827,804	26
7/03	19.7	282	6,631	28,427	106	3,013,262	2,100,000	7/07	2,256,162	34
7/04	14.6	649	11,439	39,866	106	4,225,796	3,000,000	7/08	2,788,716	52
7/05	9.9	251	6,091	45,957	106	4,871,442	3,000,000	7/09	3,192,648	53
7/06	25.9	237	2,348	48,305	80	3,864,400	2,000,000	7/10	3,588,606	8
7/07	32.1	85	648	48,953	79	3,867,287	1,500,000	7/11	3,804,456	2
7/08	15.0	56	945	49,898	69	3,442,962	700,000	7/12	4,032,456	-15
7/09	30.0	53	438	50,336	70	3,523,520	350,000	7/13	4,332,018	-19
7/10	31.1	38	298	50,634	76	3,848,184	300,000	7/14	4,649,838	-17
7/11	27.6	264	2,553	53,187	79	4,201,773	400,000	7/15	4,948,680	-15
7/12	26.3	446	4,751	57,938	80	4,635,040	650,000	7/16	5,111,028	-9
7/13	31.8	278	2,141	60,079	86	5,166,794	850,000	7/17	5,421,666	-5
7/14	30.6	186	1,522	61,601	86	5,297,686	650,000	7/18	5,850,216	-9
7/15	26.4	578	6,034	67,635	85	5,748,975	800,000	7/19	6,039,222	-5
7/16	23.7	475	6,090	73,725	85	6,266,625	1,100,000	7/20	6,109,500	3
6/24 - 7/16						Mean Percent Error (MPE)				125
						Mean Absolute Percent Error (MAPE)				166
7/6 - 7/16						Mean Percent Error (MPE)				-7
						Mean Absolute Percent Error (MAPE)				10

[1] The 1985-98 mean escapement per index point relationship (106 EPI) was used until July 6 when lag-time relationships began to prove more accurate.

[2] Best travel time estimate at the end of the season was 4 d.

[3] Estimated river fish is a subjective estimate of fish that have entered the river but have not passed the counting tower based on all available information.

Table 3. Sockeye salmon spawning escapement test-fishing data summary and comparison to tower counts, Egegik River, 1999.

	Test Fishing							Observation Tower		
Date	Fishing Time(min)	Catch (no)	Daily Index	Cumulative Index	Escapement per Index Pt.[1]	Cumulative Escapement	Estimated River Fish[3]	Date Plus Travel Time[2]	Cumulative Escapement	Percent Error of Test Fishing Estimate
6/14	28.6	5	41	41	62	2,542		6/19	0	
6/15	59.9	10	42	83	62	5,146		6/20	0	
6/16	63.1	9	31	114	62	7,068		6/21	24	29,350
6/17	59.5	51	199	313	62	19,406		6/22	48	40,329
6/18	62.7	151	574	887	62	54,994		6/23	114	48,140
6/19	62.1	77	285	1,172	62	72,664	72,000	6/24	144	50,361
6/20	62.3	115	512	1,684	62	104,408	100,000	6/25	162	64,349
6/21	63.9	92	339	2,023	62	125,426	120,000	6/26	240	52,161
6/22	61.9	37	146	2,169	62	134,478	135,000	6/27	690	19,390
6/23	37.1	80	486	2,655	62	164,610	165,000	6/28	750	21,848
6/24	49.5	134	652	3,307	62	205,034	200,000	6/29	3,720	5,412
6/25	56.5	75	312	3,619	62	224,378	200,000	6/30	9,318	2,308
6/26	61.1	9	29	3,648	62	226,176	200,000	7/1	65,718	244
6/27	54.3	160	802	4,450	62	275,900	150,000	7/2	126,720	118
6/28	32.8	212	1,636	6,086	62	377,332	250,000	7/3	338,682	11
6/29	55.3	264	1,167	7,253	62	449,686	350,000	7/4	437,118	3
6/30	53.1	352	1,627	8,880	62	550,560	450,000	7/5	536,760	3
7/1	39.4	377	2,624	11,504	62	713,248	575,000	7/6	710,244	0
7/2	50.2	313	1,790	13,294	62	824,228	650,000	7/7	973,116	-15
7/3	27.2	270	2,891	16,185	62	1,003,470	700,000	7/8	1,136,394	-12
7/4	24.1	209	2,230	18,415	62	1,141,730	750,000	7/9	1,330,404	-14
7/5	34.7	72	480	18,895	62	1,171,490	650,000	7/10	1,472,382	-20
7/6	25.6	99	916	19,811	62	1,228,282	500,000	7/11	1,562,754	-21
7/7	64.5	30	97	19,908	75	1,493,100	500,000	7/12	1,648,578	-9
7/8	76.8	11	33	19,941	75	1,495,575	350,000	7/13	1,671,756	-11
7/9	52.0	9	38	19,979	75	1,498,425	150,000	7/14	1,688,616	-11
7/10	-	-	-	-	-		-	7/15	1,708,188	-
7/11	17.6	8	109	20,088	82	1,647,216	100,000	7/16	1,716,000	-4
7/12	41.4	37	214	20,302	82	1,664,764	50,000	7/17	1,727,772	-4
7/13	31.8	39	266	20,568	82	1,686,576	35,000	7/18	1,727,772	-2
6/16 - 7/13						Mean Percent Error(MPE)				11,925
						Mean Absolute Percent Error(MAPE)				11,934
7/7 - 7/13						Mean Percent Error(MPE)				-7
						Mean Absolute Percent Error(MAPE)				7

[1] The 1996-98 mean escapement per index point relationship (62 EPI) was used until July 7 when lag-time relationships began to prove more accurate.

[2] Best travel time estimate at end of season was 5 d.

[3] Estimated river fish is a subjective estimate of fish that have entered the river but have not passed the counting tower based on all available information.

Table 4. Sockeye salmon spawning escapement test-fishing data summary and comparison to tower counts, Ugashik River, 1999.

	Test Fishing							Observation Tower		
Date	Fishing Time(min	Catch (no)	Daily Index	Cumulative Index	Escapement per Index Pt.[1]	Cumulative Escapement	Estimated River Fish[4]	Date Plus Travel Time[2]	Cumulative Escapement	Percent Error of Test Fishing Estimate
6/24	19.4	0	0	0	54	0		6/29	[3]	
6/25	82.4	5	15	15	54	810	800	6/30	[3]	
6/26	63.0	7	27	42	54	2,268	2,000	7/1	[3]	
6/27	59.2	13	53	95	54	5,130	5,000	7/2	0	
6/28	61.9	13	50	145	54	7,830	7,000	7/3	0	
6/29	62.4	28	108	253	54	13,662	10,000	7/4	0	
6/30	56.0	82	360	613	54	33,102	30,000	7/5	0	
7/1	55.6	101	459	1,072	54	57,888	50,000	7/6	0	
7/2	44.3	161	1,148	2,220	54	119,880	80,000	7/7	6	
7/3	11.4	27	573	2,793	54	150,822	100,000	7/8	33,186	354
7/4	12.8	81	1,792	4,585	54	247,590	200,000	7/9	237,126	4
7/5	13.8	164	2,779	7,364	54	397,656	350,000	7/10	426,780	-7
7/6	11.2	220	4,732	12,096	54	653,184	500,000	7/11	610,188	7
7/7	6.0	69	2,727	14,823	54	800,442	500,000	7/12	938,928	-15
7/8	25.2	101	1,437	16,260	54	878,040	600,000	7/13	1,293,270	-32
7/9	43.3	48	263	16,523	54	892,242	450,000	7/14	1,371,798	-35
7/10	-	-	-	-	-	-	-	7/15	1,460,058	
7/11	25.1	37	353	16,876	54	911,304	150,000	7/16	1,505,904	-39
7/12	23.6	24	239	17,115	54	924,210	150,000	7/17	1,527,366	-39
7/13	5.5	1	44	17,159	54	926,586	NE [5]	7/18	1,537,914	-40
7/14	26.3	9	82	17,241	54	931,014	NE [5]	7/19	1,540,962	-40
7/15	28.1	10	86	17,327	54	935,658	NE [5]	7/20	1,547,310	-40
7/16	29.1	8	66	17,393	54	939,222	NE [5]	7/21	1,555,998	-40
7/17	13.7	5	87	17,480	83	1,450,840	20,000	7/22	1,580,808	-8
7/18	53.5	15	69	17,549	84	1,474,116	20,000	7/23	1,606,242	-8

7/3 - 7/18	Mean Percent Error(MPE)	1
	Mean Absolute Percent Error(MAPE)	44
7/17 - 7/18	Mean Percent Error(MPE)	-8
	Mean Absolute Percent Error(MAPE)	8

[1] The 1985-98 mean escapement per index point relationship (54 EPI) was used until July 17 when lag-time relationships began to prove more accurate.

[2] Best travel time estimate at end of season was 5 d.

[3] Observation towers not in operation.

[4] Estimated river fish is a subjective estimate of fish that have entered the river but have not passed the counting tower based on all available information.

[5] No estimate made.

Table 5. Sockeye salmon spawning escapement test-fishing data summary and comparison to tower counts, Igushik River, 1999.

	Test Fishing							Observation Tower		
Date	Fishing Time(min	Catch (no)	Daily Index	Cumulative Index	Escapement per Index Pt.[1]	Cumulative Escapement	Estimated River Fish[4]	Date Plus Travel Time[2]	Cumulative Escapement	Percent Error of Test Fishing Estimate
6/16	97.2	0	0	0	57	-		6/18	[3]	
6/17	113.4	0	0	0	57	-		6/19	[3]	
6/18	99.2	0	0	0	57	-		6/20	[3]	
6/19	113.2	0	0	0	57	-		6/21	[3]	
6/20	105.2	0	0	0	57	-		6/22	[3]	
6/21	102.6	1	2	2	57	114		6/23	[3]	
6/22	99.3	0	0	2	57	114		6/24	[3]	
6/23	52.9	0	0	2	57	114		6/25	6	
6/24	63.1	6	21	23	57	1,311	1,300	6/26	0	
6/25	44.0	1	5	28	57	1,596	1,500	6/27	0	
6/26	46.6	26	126	154	57	8,778	5,000	6/28	0	
6/27	86.1	104	363	517	57	29,469	15,000 [5]	6/29	0	
6/28	78.1	99	323	840	57	47,880	25,000 [5]	6/30	2,616	1,730
6/29	90.2	130	445	1,285	57	73,245	35,000 [5]	7/1	7,008	945
6/30	64.4	188	886	2,171	57	123,747	60,000 [5]	7/2	29,346	322
7/1	65.7	150	685	2,856	57	162,792	60,000 [5]	7/3	58,842	177
7/2	63.0	191	977	3,833	57	218,481	110,000 [5]	7/4	91,464	139
7/3	46.9	296	2,661	6,494	40	259,760	150,000	7/5	137,928	88
7/4	33.9	213	1,823	8,317	28	232,876	140,000	7/6	178,278	31
7/5	20.4	133	2,032	10,349	21	217,329	85,000	7/7	223,764	-3
7/6	17.6	205	3,400	13,749	21	288,729	115,000	7/8	262,836	10
7/7	20.7	126	1,923	15,672	21	329,112	115,000	7/9	304,176	8
7/8	15.3	67	1,322	16,994	19	322,886	60,000	7/10	328,050	-2
6/27 - 7/14						Mean Percent Error(MPE)				215
						Mean Absolute Percent Error(MAPE)				216
7/2 - 7/14						Mean Percent Error(MPE)				25
						Mean Absolute Percent Error(MAPE)				25

[1] The 1988-92, 94-98 mean escapement per index point relationship (57 EPI) was used until July 3 when lag-time relationships began to prove more accurate.

[2] Best travel time estimate at end of season was 2 d.

[3] Observation towers not in operation.

[4] Estimated river fish is a subjective estimate of fish that have entered the river but have not passed the counting tower based on all available information.

[5] EPI was halved for the daily in-river fish estimate based on aerial surveys and low tower counts.

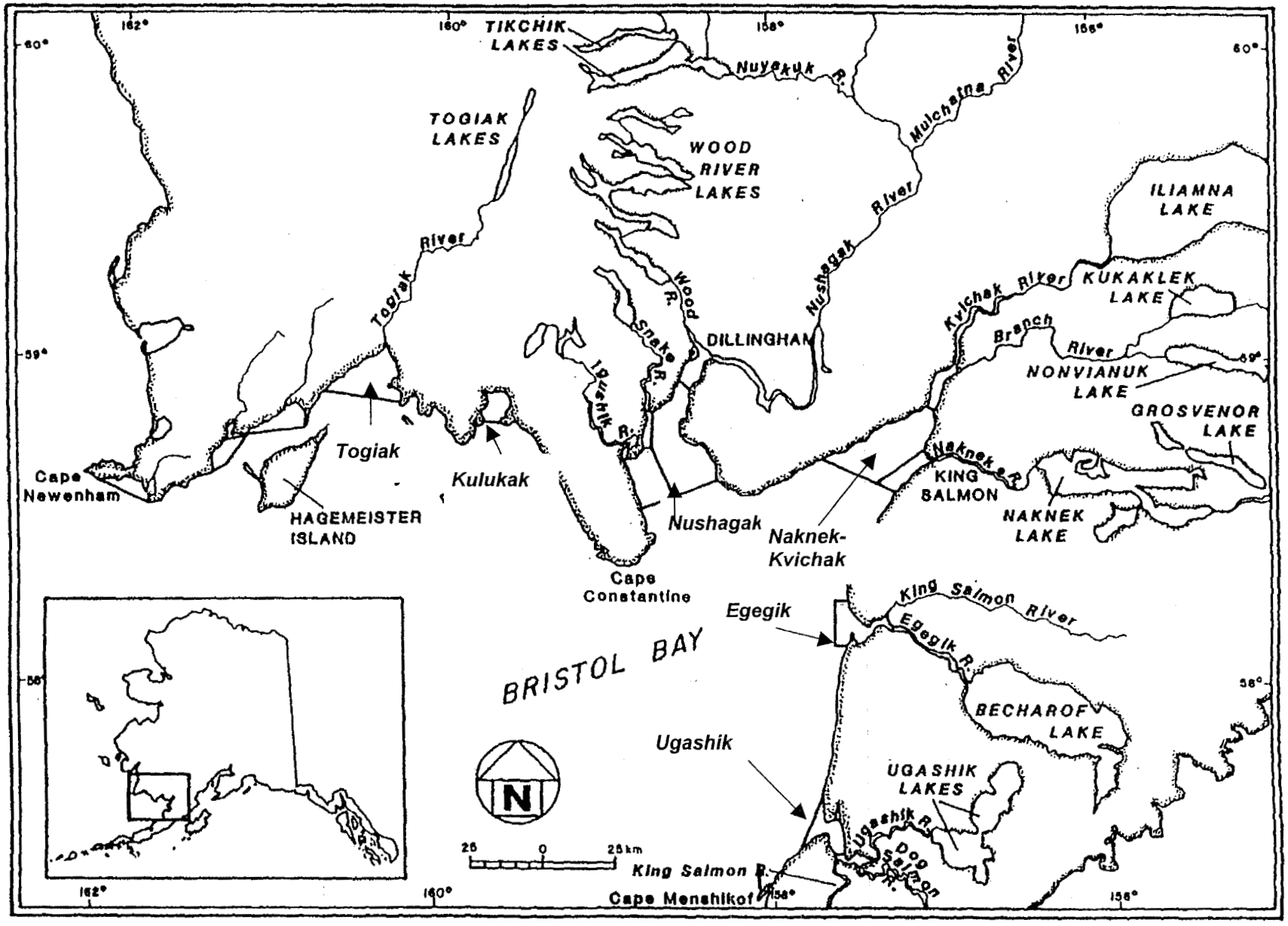

Figure 1. Bristol Bay major river systems and commercial fishing districts.

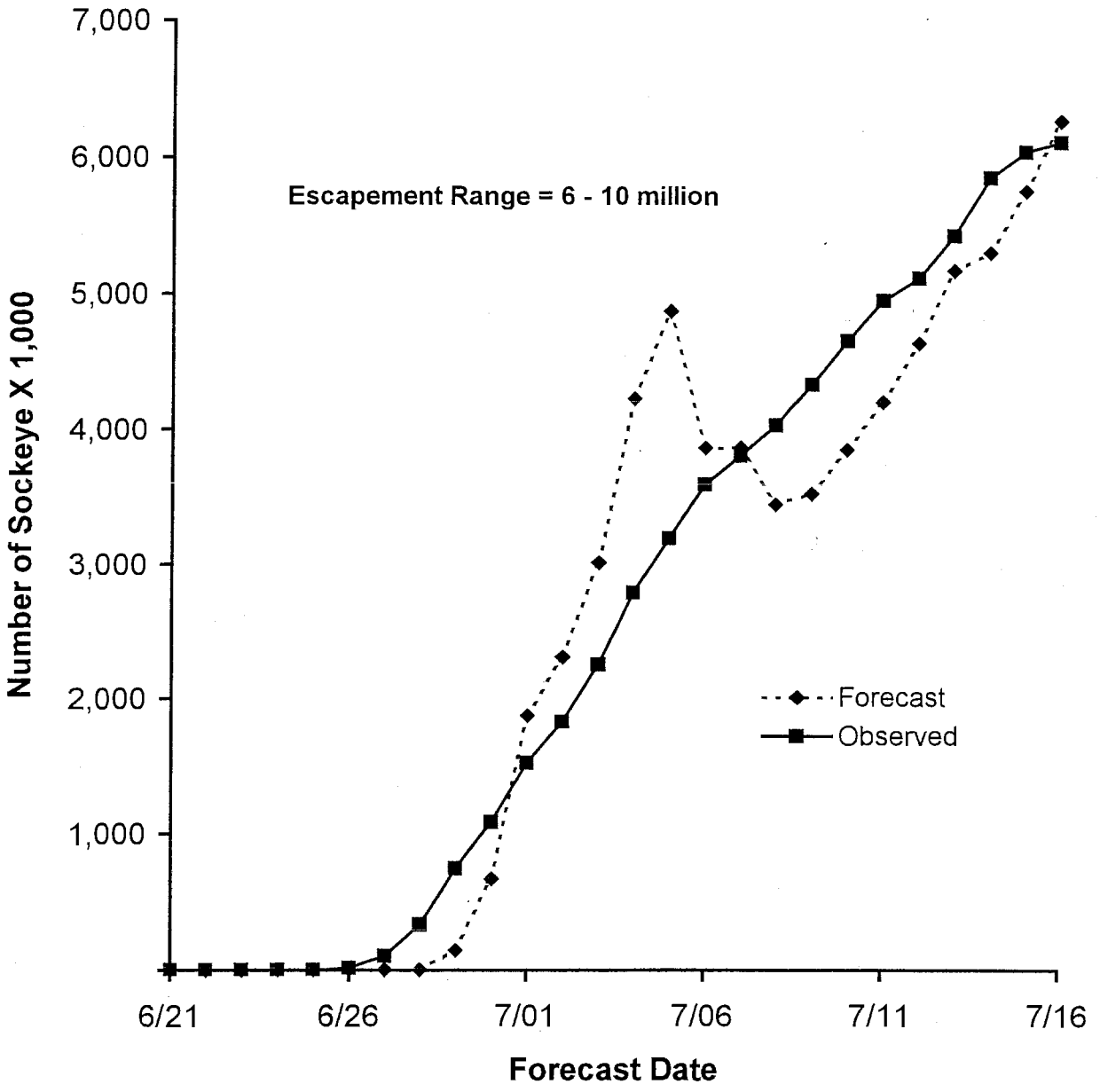

Figure 2. Comparison of inseason sockeye salmon test fish forecast and observed escapement, Kvichak River, 1999.

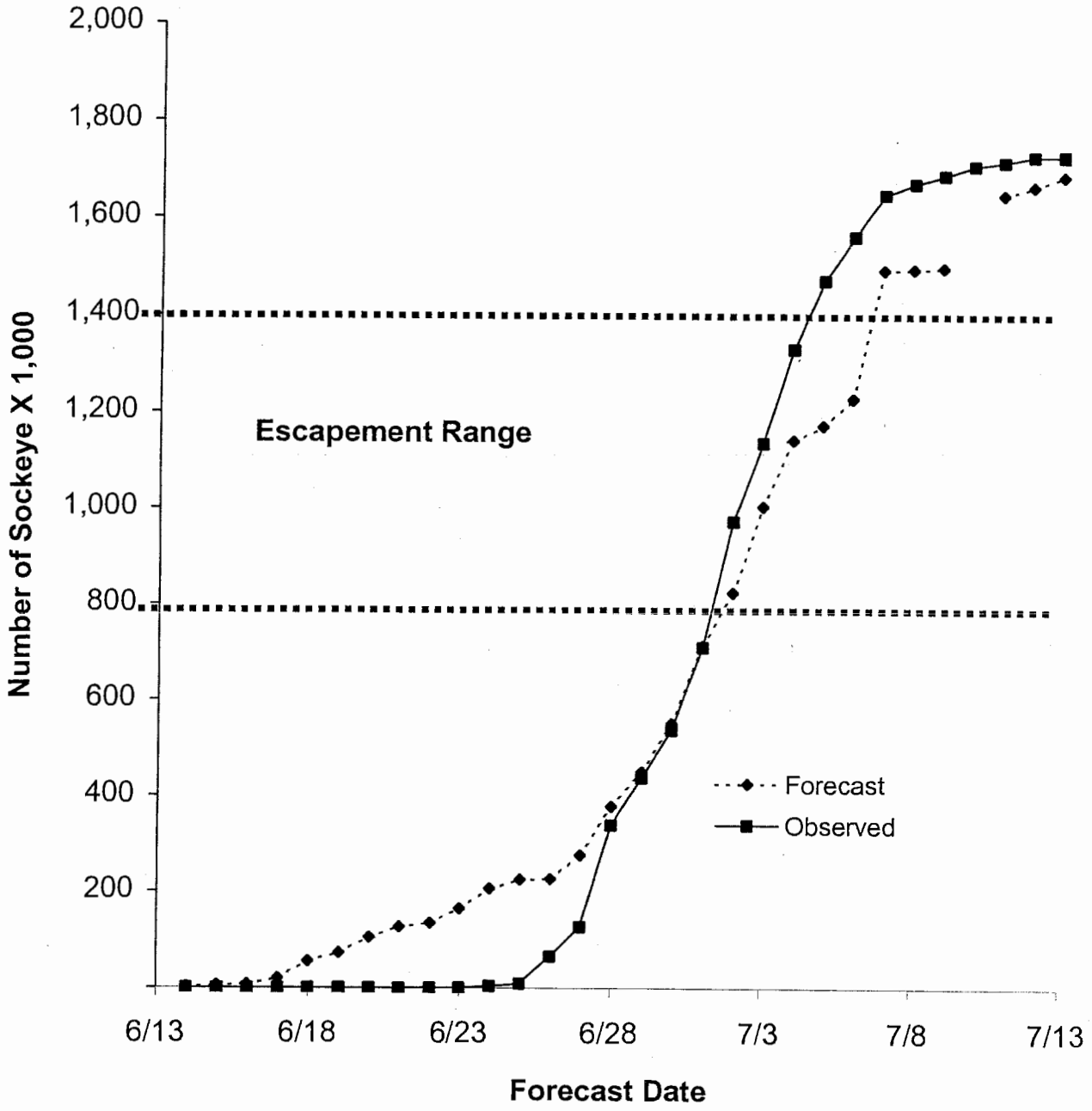

Figure 3. Comparison of inseason sockeye salmon test fish forecast and observed escapement, Egegik River, 1999.

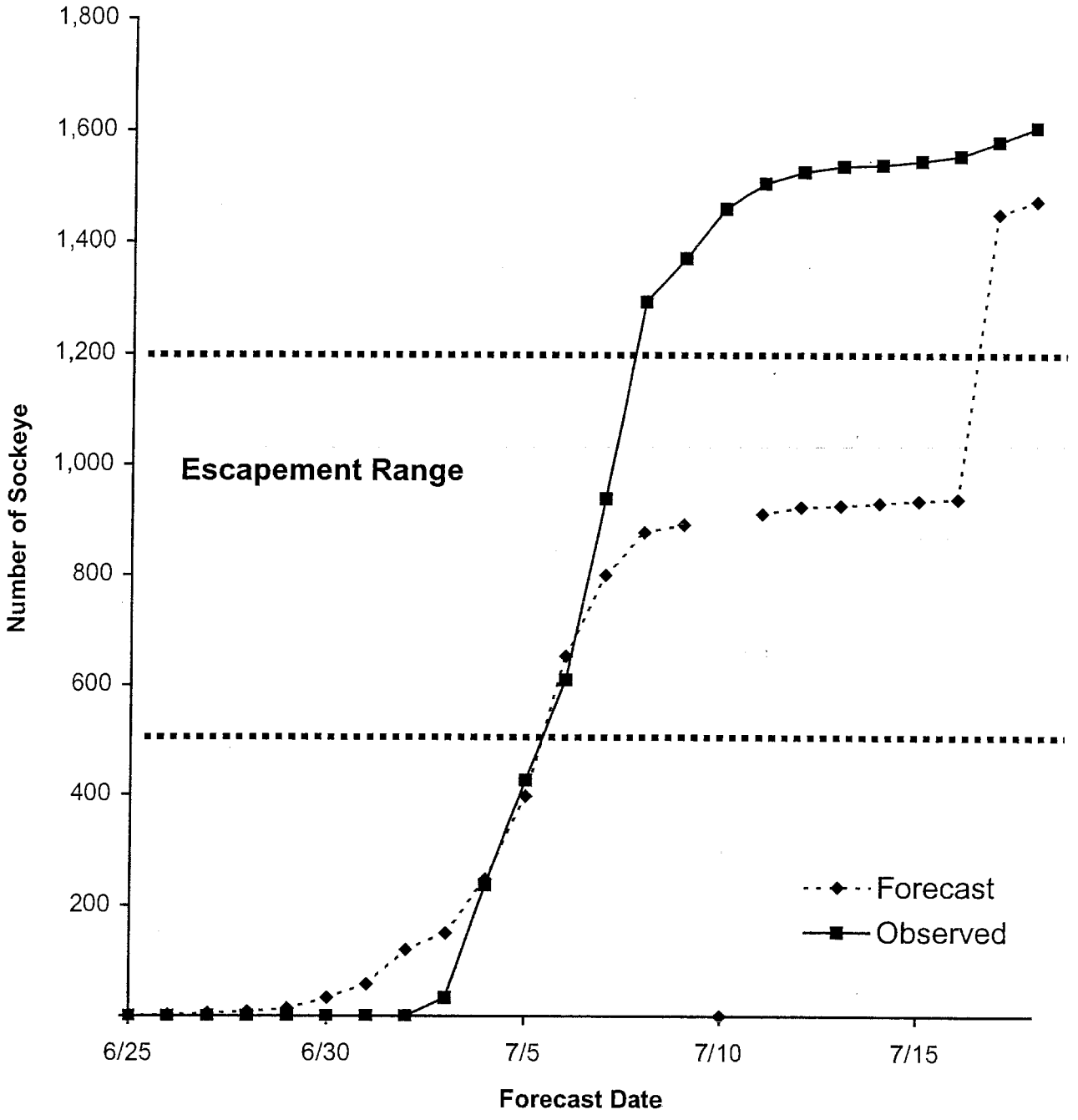

Figure 4. Comparison of inseason sockeye salmon test fish forecast and observed escapement, Ugashik River, 1999.

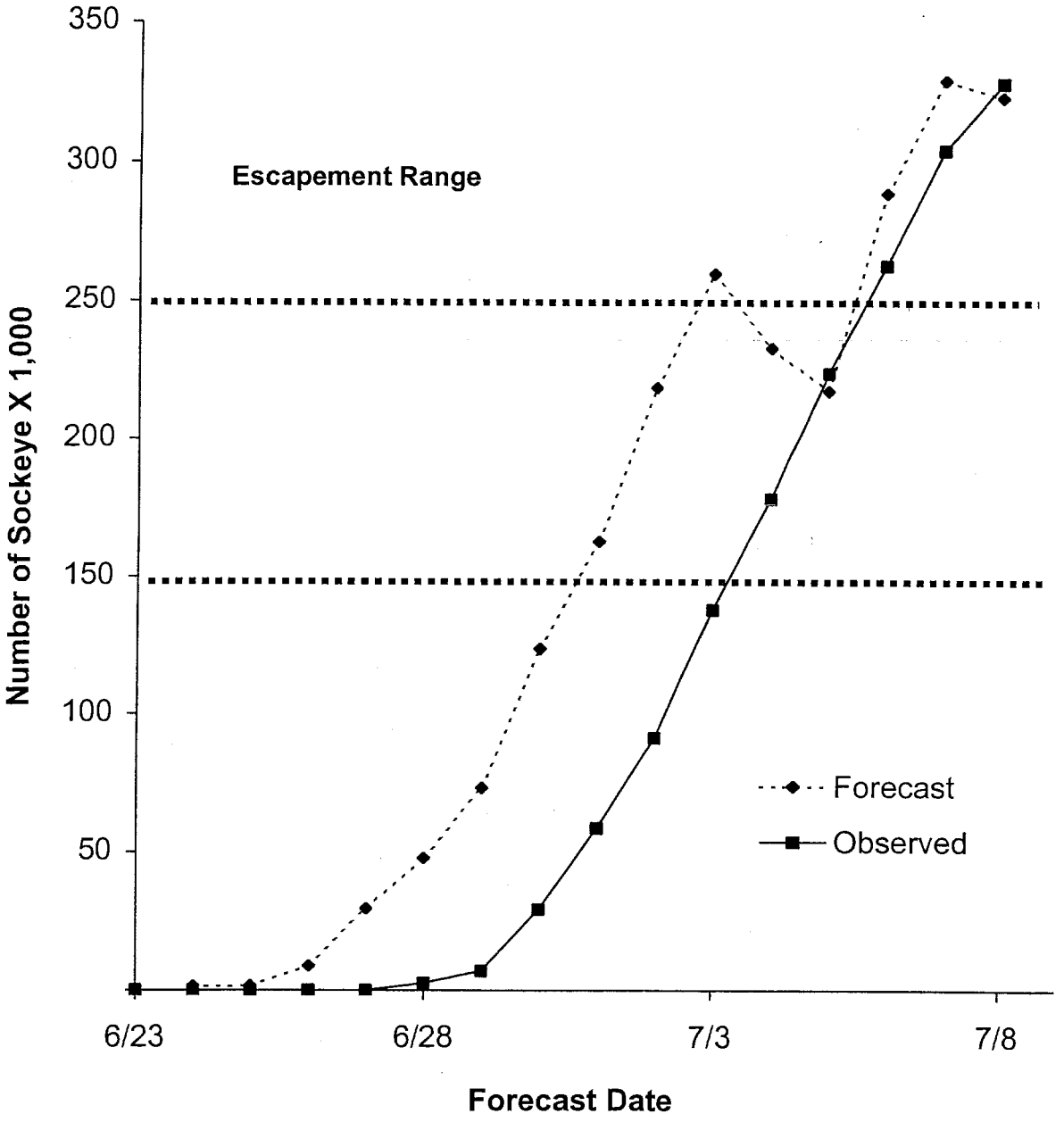

Figure 5. Comparison of inseason sockeye salmon test fish forecast and observed escapement, Igushik River, 1999.

APPENDIX

Appendix A.1. Sockeye salmon test-fishing data, Kvichak River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/21	1	1	10.5	0	0	11
6/21	2	1	11.0	0	0	11
6/21	3	2	10.5	0	0	11
6/21	4	2	9.8	0	0	11
6/21	5	1	9.7	0	0	11
6/21	6	1	10.0	0	0	11
6/21	7	2	10.0	0	0	11
6/21	8	2	9.8	0	0	11
6/22	9	1	9.7	0	0	11
6/22	10	1	10.0	0	0	11
6/22	11	2	10.0	0	0	11
6/22	12	2	9.8	0	0	11
6/23	13	1	9.5	0	0	12
6/23	14	1	9.8	0	0	12
6/23	15	2	10.8	0	0	12
6/23	16	2	11.0	0	0	12
6/23	17	1	10.3	0	0	12
6/23	18	1	10.5	0	0	12
6/23	19	2	9.5	0	0	12
6/23	20	2	9.5	0	0	12
6/24	21	1	9.8	0	0	11
6/24	22	1	10.5	0	0	11
6/24	23	2	10.5	3	69	11
6/24	24	2	10.5	1	23	11
6/24	25	1	10.5	2	46	11
6/24	26	1	10.3	0	0	11
6/24	27	2	9.3	3	77	11
6/24	28	2	10.0	5	120	11
6/25	29	1	10.5	0	0	11
6/25	30	1	9.5	0	0	11
6/25	31	2	9.8	0	0	11
6/25	32	2	10.5	0	0	11
6/25	33	1	10.0	0	0	11
6/25	34	1	9.8	1	25	11
6/25	35	2	9.3	0	0	11
6/25	36	2	9.5	1	25	11
6/26	37	1	10.3	0	0	11
6/26	38	1	10.5	0	0	11
6/26	39	2	10.3	0	0	11
6/26	40	2	10.8	0	0	11
6/26	41	1	10.3	0	0	11
6/26	42	1	10.3	0	0	11
6/26	43	2	10.3	0	0	11
6/26	44	2	9.5	0	0	11

Appendix A.1. Sockeye salmon test-fishing data, Kvichak River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/27	45	1	9.3	0	0	11
6/27	46	1	9.8	0	0	11
6/27	47	2	9.5	1	25	11
6/27	48	2	10.0	0	0	11
6/27	49	1	8.3	0	0	11
6/27	50	2	9.3	0	0	11
6/27	51	2	12.5	0	0	11
6/28	52	1	9.8	0	0	12
6/28	53	1	10.0	0	0	12
6/28	54	2	10.3	0	0	12
6/28	55	2	10.3	0	0	12
6/28	56	1	10.3	0	0	11
6/28	57	1	9.8	0	0	11
6/28	58	2	9.8	0	0	11
6/28	59	2	10.3	0	0	11
6/29	60	1	9.5	0	0	12
6/29	61	1	10.0	0	0	12
6/29	62	2	10.3	0	0	12
6/29	63	2	9.5	0	0	12
6/29	64	1	9.8	11	269	12
6/29	65	1	8.3	4	116	12
6/29	66	2	6.8	159	5612	12
6/29	67	2	6.5	124	4579	12
6/30	68	1	8.0	9	270	12
6/30	69	1	8.5	28	791	12
6/30	70	2	6.8	123	4341	12
6/30	71	2	7.0	126	4320	12
6/30	72	2	7.3	90	2959	12
6/30	73	2	2.6	184	16985	12
7/1	74	1	6.5	153	5649	12
7/1	75	2	2.6	192	17723	12
7/1	76	1	6.5	137	5059	12
7/1	77	2	2.4	171	17100	12
7/2	78	1	7.0	90	3086	12
7/2	79	2	4.9	103	5045	12
7/2	80	1	7.0	85	2914	12
7/2	81	2	4.5	100	5333	12
7/3	82	1	7.5	3	96	12
7/3	83	2	6.8	61	2153	12
7/3	84	1	3.8	97	6126	12
7/3	85	2	1.6	121	18150	12
7/4	86	1	5.4	197	8756	12
7/4	87	2	3.6	159	10600	12
7/4	88	1	3.3	132	9600	12

Appendix A.1. Sockeye salmon test-fishing data, Kvichak River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
7/4	89	2	2.3	161	16800	12
7/5	90	1	4.9	137	6710	12
7/5	91	2	5.0	114	5472	12
7/6	92	1	6.9	45	1565	12
7/6	93	2	6.9	25	870	12
7/6	94	1	6.5	34	1255	12
7/6	95	2	5.6	133	5700	12
7/7	96	1	7.5	0	0	12
7/7	97	2	7.0	50	1714	12
7/7	98	1	9.8	32	784	11
7/7	99	2	7.8	3	92	11
7/8	100	1	8.0	7	210	13
7/8	101	2	7.0	49	1680	13
7/9	102	1	7.5	2	64	13
7/9	103	2	7.0	24	823	13
7/9	104	1	8.0	0	0	13
7/9	105	2	7.5	27	864	13
7/10	106	1	8.3	3	87	13
7/10	107	2	8.0	16	480	13
7/10	108	1	7.5	0	0	13
7/10	109	2	7.3	19	625	13
7/11	110	1	7.8	1	31	13
7/11	111	2	7.5	78	2496	13
7/11	112	1	5.3	122	5525	13
7/11	113	2	7.0	63	2160	13
7/12	114	1	7.3	71	2334	13
7/12	115	2	7.5	107	3424	13
7/12	116	1	3.5	135	9257	13
7/12	117	2	8.0	133	3990	13
7/13	118	1	7.5	73	2336	13
7/13	119	2	7.5	101	3232	13
7/13	120	1	8.0	59	1770	13
7/13	121	2	8.8	45	1227	13
7/14	122	1	7.3	57	1874	13
7/14	123	2	7.0	88	3017	13
7/14	124	1	8.0	9	270	13
7/14	125	2	8.3	32	925	13
7/15	126	1	8.3	46	1330	12
7/15	127	2	7.8	128	3938	12
7/15	128	1	5.3	193	8740	12
7/15	129	2	5.0	211	10128	12
7/16	130	1	4.1	129	7551	12
7/16	131	2	3.3	147	10691	12
7/16	132	1	9.3	83	2142	12
7/16	133	2	7.0	116	3977	12

Appendix A.2. Sockeye salmon test-fishing data, Egegik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/14	1	1	8.5	2	57	-
6/14	2	2	6.9	1	35	-
6/14	3	1	6.6	1	36	-
6/14	4	2	6.6	1	36	-
6/15	5	1	6.3	1	38	-
6/15	6	2	5.6	0	0	-
6/15	7	1	9.5	1	25	-
6/15	8	2	10.5	0	0	-
6/15	9	1	7.0	2	69	-
6/15	10	2	6.9	2	70	-
6/15	11	1	7.1	3	101	-
6/15	12	2	7.0	1	34	-
6/16	13	1	6.4	0	0	-
6/16	14	2	5.9	0	0	-
6/16	15	1	7.4	2	65	-
6/16	16	2	7.1	1	34	-
6/16	17	1	9.1	0	0	-
6/16	18	2	10.1	3	71	-
6/16	19	1	7.5	1	32	-
6/16	20	2	9.6	2	50	-
6/17	21	1	7.5	0	0	-
6/17	22	2	6.8	3	106	-
6/17	23	1	7.8	0	0	-
6/17	24	2	6.6	5	182	-
6/17	25	1	7.0	2	69	-
6/17	26	2	8.3	19	549	-
6/17	27	1	8.0	9	270	-
6/17	28	2	7.5	13	416	-
6/18	29	1	7.0	4	137	9
6/18	30	2	7.8	4	123	9
6/18	31	1	7.5	1	32	9
6/18	32	2	7.1	5	169	9
6/18	33	1	8.1	21	622	9
6/18	34	2	9.9	48	1164	9
6/18	35	1	4.9	30	1469	9
6/18	36	2	10.4	38	877	9
6/19	37	1	7.6	4	126	9
6/19	38	2	7.0	8	274	9
6/19	39	1	7.0	1	34	9
6/19	40	2	7.1	2	68	9
6/19	41	1	7.9	19	577	10
6/19	42	2	8.3	5	145	10
6/19	43	1	8.8	24	655	10
6/19	44	2	8.4	14	400	10

Appendix A.2. Sockeye salmon test-fishing data, Egegik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/20	45	1	7.1	1	34	10
6/20	46	2	8.5	12	339	10
6/20	47	1	7.4	3	97	10
6/20	48	2	8.3	10	289	10
6/20	49	1	8.5	16	452	9
6/20	50	2	3.5	24	1646	9
6/20	51	1	8.6	23	642	9
6/20	52	2	10.4	26	600	9
6/21	53	1	7.3	2	66	8
6/21	54	2	9.9	14	339	8
6/21	55	1	7.8	0	0	8
6/21	56	2	8.4	11	314	8
6/21	57	1	7.0	12	411	10
6/21	58	2	8.6	28	781	10
6/21	59	1	7.3	9	296	10
6/21	60	2	7.6	16	505	10
6/22	61	1	9.9	4	97	8
6/22	62	2	7.6	6	190	8
6/22	63	1	7.5	3	96	8
6/22	64	2	7.8	4	123	8
6/22	65	1	7.3	5	164	9
6/22	66	2	7.4	9	292	9
6/22	67	1	7.4	1	32	9
6/22	68	2	7.0	5	171	9
6/23	69	1	7.0	1	34	8
6/23	70	2	9.9	46	1115	8
6/23	71	1	10.3	6	140	8
6/23	72	2	9.9	27	655	8
6/24	73	1	7.8	12	369	9
6/24	74	2	7.8	30	923	9
6/24	75	1	8.0	18	540	9
6/24	76	2	9.0	25	667	9
6/24	77	1	8.3	43	1243	10
6/24	78	2	8.6	6	167	10
6/25	79	1	7.0	13	446	9
6/25	80	2	7.6	24	758	9
6/25	81	1	7.3	5	164	9
6/25	82	2	7.1	18	609	9
6/25	83	1	6.9	4	139	10
6/25	84	2	7.3	4	132	10
6/25	85	1	6.8	4	141	10
6/25	86	2	6.5	3	111	10
6/26	87	1	5.5	0	0	-
6/26	88	2	5.9	1	41	-

Appendix A.2. Sockeye salmon test-fishing data, Egegik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/26	89	1	5.5	0	0	-
6/26	90	2	7.0	1	34	-
6/26	91	1	12.6	5	95	-
6/26	92	2	8.5	1	28	-
6/26	93	1	8.0	1	30	-
6/26	94	2	8.1	0	0	-
6/27	95	1	7.5	4	128	9
6/27	96	2	7.1	6	203	9
6/27	97	1	7.1	1	34	9
6/27	98	2	6.5	7	259	9
6/27	99	1	5.6	68	2914	10
6/27	100	2	7.5	4	128	10
6/27	101	1	6.0	61	2440	10
6/27	102	2	7.0	9	309	10
6/28	103	1	6.4	21	788	12
6/28	104	2	6.6	13	473	12
6/28	105	1	5.3	77	3487	11
6/28	106	2	6.1	49	1928	11
6/28	107	1	3.8	39	2463	11
6/28	108	2	4.6	13	678	11
6/29	109	1	6.9	35	1217	10
6/29	110	2	6.0	45	1800	10
6/29	111	1	7.0	30	1029	10
6/29	112	2	7.4	20	649	10
6/29	113	1	7.3	38	1249	10
6/29	114	2	6.4	46	1725	10
6/29	115	1	7.8	29	892	10
6/29	116	2	6.5	21	775	10
6/30	117	1	6.4	41	1538	10
6/30	118	2	6.1	31	1220	10
6/30	119	1	6.9	21	730	10
6/30	120	2	7.9	42	1276	10
6/30	121	1	5.5	68	2967	11
6/30	122	2	7.0	48	1646	11
6/30	123	1	6.8	53	1871	11
6/30	124	2	6.5	48	1772	11
7/1	125	1	5.0	69	3312	9
7/1	126	2	3.5	122	8366	9
7/1	127	1	3.3	30	2182	9
7/1	128	2	4.1	42	2459	9
7/1	129	1	5.8	46	1903	9
7/1	130	2	5.6	19	814	9
7/1	131	1	6.0	44	1760	9
7/1	132	2	6.1	5	197	9

Appendix A.2. Sockeye salmon test-fishing data, Egegik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
7/2	133	1	6.1	2	79	8
7/2	134	2	7.6	20	632	8
7/2	135	1	7.8	4	123	8
7/2	136	2	9.5	17	430	8
7/2	137	1	5.3	120	5434	9
7/2	138	2	4.1	29	1698	9
7/2	139	1	4.8	58	2900	9
7/2	140	2	5.0	63	3024	9
7/3	141	1	6.3	25	952	8
7/3	142	2	3.1	113	8748	8
7/3	143	1	2.4	9	900	8
7/3	144	2	2.6	38	3508	8
7/3	145	1	4.5	32	1707	9
7/3	146	2	8.3	53	1533	9
7/4	147	1	6.1	67	2636	9
7/4	148	2	5.0	89	4272	9
7/4	149	1	5.6	28	1200	10
7/4	150	2	7.4	25	811	10
7/5	151	1	7.8	5	154	10
7/5	152	2	7.8	17	523	10
7/5	153	1	9.3	14	361	9
7/5	154	2	9.8	36	882	9
7/6	155	1	7.1	14	473	9
7/6	156	2	6.6	61	2218	9
7/6	157	1	5.9	21	854	9
7/6	158	2	6.0	3	120	9
7/7	159	1	21.9	16	175	9
7/7	160	2	21.4	9	101	9
7/7	161	1	10.5	1	23	11
7/7	162	2	10.7	4	90	11
7/8	163	1	10.4	2	46	10
7/8	164	2	10.8	3	67	10
7/8	165	1	10.6	1	23	10
7/8	166	2	10.4	0	0	10
7/8	167	1	10.5	3	69	11
7/8	168	2	7.8	2	62	11
7/8	169	1	7.9	0	0	11
7/8	170	2	8.4	0	0	11
7/9	171	1	8.4	0	0	11
7/9	172	2	8.5	2	57	11
7/9	173	1	17.4	4	55	12
7/9	174	2	17.7	3	41	12
7/11	175	1	8.8	3	82	10
7/11	176	2	8.8	5	136	10

Appendix A.2. Sockeye salmon test-fishing data, Egegik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
7/12	177	1	10.5	4	91	12
7/12	178	2	10.4	1	23	12
7/12	179	1	9.5	12	303	13
7/12	180	2	11.0	20	436	13
7/13	181	1	6.6	3	109	12
7/13	182	2	10.6	22	498	12
7/13	183	1	7.6	8	253	12
7/13	184	2	7.0	6	206	12

Appendix A.3. Sockeye salmon test-fishing data, Ugashik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/24	1	1	8.3	0	0	12
6/24	2	2	11.1	0	0	12
6/25	3	1	9.7	1	25	12
6/25	4	2	9.0	0	0	12
6/25	5	1	10.0	0	0	12
6/25	6	2	11.0	2	44	12
6/25	7	1	10.7	0	0	12
6/25	8	2	8.9	2	54	12
6/25	9	1	9.7	0	0	12
6/25	10	2	13.4	0	0	12
6/26	11	1	8.6	1	28	12
6/26	12	2	6.4	1	38	12
6/26	13	1	6.4	1	38	12
6/26	14	2	6.7	0	0	12
6/26	15	1	9.1	2	53	11
6/26	16	2	6.5	1	37	11
6/26	17	1	8.6	0	0	11
6/26	18	2	10.7	1	22	11
6/27	19	1	6.4	2	75	11
6/27	20	2	6.8	2	71	11
6/27	21	1	6.7	3	108	11
6/27	22	2	7.2	1	33	11
6/27	23	1	7.5	2	64	11
6/27	24	2	7.5	0	0	11
6/27	25	1	7.8	0	0	11
6/27	26	2	9.3	3	77	11
6/28	27	1	7.6	0	0	13
6/28	28	2	8.4	2	57	13
6/28	29	1	7.7	1	31	13
6/28	30	2	7.8	2	62	13
6/28	31	1	8.3	4	116	12
6/28	32	2	8.3	0	0	12
6/28	33	1	8.0	3	90	12
6/28	34	2	5.8	1	41	12
6/29	35	1	7.4	3	97	12
6/29	36	2	7.7	3	94	12
6/29	37	1	7.8	3	92	12
6/29	38	2	8.4	3	86	12
6/29	39	1	7.6	7	221	12
6/29	40	2	7.4	2	65	12
6/29	41	1	7.9	7	213	12
6/29	42	2	8.2	0	0	12
6/30	43	1	7.2	4	133	13
6/30	44	2	7.6	9	284	13

Appendix A.3. Sockeye salmon test-fishing data, Ugashik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/30	45	1	6.9	1	35	13
6/30	46	2	8.0	7	210	13
6/30	47	1	6.7	31	1110	13
6/30	48	2	5.9	4	163	13
6/30	49	1	6.5	22	812	13
6/30	50	2	7.2	4	133	13
7/1	51	1	7.3	8	263	13
7/1	52	2	7.3	17	559	13
7/1	53	1	7.0	6	206	13
7/1	54	2	7.4	6	195	13
7/1	55	1	5.7	26	1095	12
7/1	56	2	7.2	2	67	12
7/1	57	1	6.7	33	1182	12
7/1	58	2	7.0	3	103	12
7/2	59	1	6.5	12	443	12
7/2	60	2	6.3	25	952	12
7/2	61	1	6.4	18	675	12
7/2	62	2	6.6	2	73	12
7/2	63	1	5.8	75	3103	10
7/2	64	2	5.3	4	181	10
7/2	65	1	1.4	21	3600	10
7/2	66	2	6.0	4	160	10
7/3	67	1	5.8	8	331	10
7/3	68	2	5.6	19	814	10
7/4	69	2	6.0	20	800	11
7/4	70	1	3.8	18	1137	12
7/4	71	2	3.0	43	3440	12
7/5	72	1	3.0	22	1760	10
7/5	73	2	5.0	68	3264	10
7/5	74	1	2.8	30	2571	11
7/5	75	2	3.0	44	3520	11
7/6	76	1	3.5	69	4731	11
7/6	77	2	3.1	52	4026	11
7/6	78	1	2.2	30	3273	11
7/6	79	2	2.4	69	6900	11
7/7	80	1	3.2	43	3225	14
7/7	81	2	2.8	26	2229	14
7/8	82	1	3.1	32	2477	12
7/8	83	2	3.3	32	2327	12
7/8	84	1	9.1	16	422	12
7/8	85	2	9.7	21	520	12
7/9	86	1	4.8	5	250	12
7/9	87	2	5.4	4	178	12
7/9	88	1	5.5	10	436	12
7/9	89	2	6.0	4	160	12

Appendix A.3. Sockeye salmon test-fishing data, Ugashik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
7/9	90	1	4.7	1	51	13
7/9	91	2	5.3	10	453	13
7/9	92	1	5.8	7	290	13
7/9	93	2	5.8	7	290	13
7/11	94	1	5.9	7	285	13
7/11	95	2	6.0	10	400	13
7/11	96	1	6.5	9	332	14
7/11	97	2	6.7	11	394	14
7/12	98	1	5.7	6	253	15
7/12	99	2	6.2	13	503	15
7/12	100	1	5.6	1	43	14
7/12	101	2	6.1	4	157	14
7/13	102	2	5.5	1	43	14
7/14	103	1	6.1	2	79	14
7/14	104	2	6.9	2	70	14
7/14	105	1	6.3	2	76	14
7/14	106	2	7.0	3	103	14
7/15	107	1	6.7	2	72	14
7/15	108	2	7.1	3	101	14
7/15	109	1	6.8	3	106	14
7/15	110	2	7.5	2	64	14
7/16	111	1	6.9	3	104	15
7/16	112	2	6.7	1	36	15
7/16	113	1	7.9	1	30	15
7/16	114	2	7.6	3	95	15
7/17	115	1	6.0	2	80	15
7/17	116	2	7.7	3	94	15
7/18	117	1	5.8	3	124	15
7/18	118	2	7.2	1	33	15
7/18	119	1	6.1	3	118	15
7/18	120	2	7.0	0	0	15
7/18	121	1	5.7	1	42	13
7/18	122	2	6.8	1	35	13
7/18	123	1	8.1	2	59	13
7/18	124	2	6.8	4	141	13

Appendix A.4. Sockeye salmon test-fishing data, Igushik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/16	1	1	12.3	0	0	10
6/16	2	2	11	0	0	10
6/16	3	1	11.5	0	0	10
6/16	4	2	9.3	0	0	10
6/16	5	1	12.5	0	0	11
6/16	6	2	15.3	0	0	11
6/16	7	1	11.3	0	0	11
6/16	8	2	14	0	0	11
6/17	9	1	15.5	0	0	11
6/17	10	2	13.8	0	0	11
6/17	11	1	15.3	0	0	11
6/17	12	2	14	0	0	11
6/17	13	1	13	0	0	11
6/17	14	2	14.5	0	0	11
6/17	15	1	13	0	0	11
6/17	16	2	14.3	0	0	11
6/18	17	1	12.5	0	0	11
6/18	18	2	13.3	0	0	11
6/18	19	1	12.5	0	0	11
6/18	20	2	15	0	0	11
6/18	21	1	12.3	0	0	11
6/18	22	2	9.8	0	0	11
6/18	23	1	12.5	0	0	11
6/18	24	2	11.3	0	0	11
6/19	25	1	13.5	0	0	11
6/19	26	2	13.3	0	0	11
6/19	27	1	15	0	0	11
6/19	28	2	13.5	0	0	11
6/19	29	1	14.8	0	0	11
6/19	30	2	14.3	0	0	11
6/19	31	1	14.3	0	0	11
6/19	32	2	14.5	0	0	11
6/20	33	1	13.8	0	0	11
6/20	34	2	14	0	0	11
6/20	35	1	15	0	0	11
6/20	36	2	11.5	0	0	11
6/20	37	1	11	0	0	11
6/20	38	2	13.3	0	0	11
6/20	39	1	11.8	0	0	11
6/20	40	2	14.8	0	0	11
6/21	41	1	14.8	0	0	12
6/21	42	2	11.8	0	0	12
6/21	43	1	13	0	0	12
6/21	44	2	15.3	1	15	12

Appendix A.4. Sockeye salmon test-fishing data, Igushik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/21	45	1	12.3	0	0	12
6/21	46	2	10.8	0	0	12
6/21	47	1	13.3	0	0	12
6/21	48	2	11.3	0	0	12
6/22	49	1	12.5	0	0	12
6/22	50	2	14.5	0	0	12
6/22	51	1	13.3	0	0	12
6/22	52	2	12.5	0	0	12
6/22	53	1	12	0	0	12
6/22	54	2	11	0	0	12
6/22	55	1	11	0	0	12
6/22	56	2	12.5	0	0	12
6/23	57	1	12.8	0	0	12.5
6/23	58	2	13	0	0	12.5
6/23	59	1	13.8	0	0	12.5
6/23	60	2	13.3	0	0	12.5
6/24	61	1	10	0	0	12.5
6/24	62	1	14	3	51	12.5
6/24	63	2	12	0	0	12.5
6/24	64	1	13.8	3	52	12.5
6/24	65	2	13.3	0	0	12.5
6/25	66	1	11	0	0	13
6/25	67	2	9	0	0	13
6/25	68	1	13	1	18	13
6/25	69	2	11	0	0	13
6/26	70	1	12.5	14	269	13
6/26	71	2	9.3	0	0	13
6/26	72	1	12.3	10	198	13
6/26	73	2	12.5	2	39	13
6/27	74	1	12.5	0	0	13
6/27	75	2	13	4	74	13
6/27	76	1	13	1	19	13
6/27	77	2	13	6	112	13
6/27	78	1	8	30	900	13
6/27	79	2	9.8	0	0	13
6/27	80	1	8.3	36	1048	13
6/27	81	2	8.5	27	762	13
6/28	82	1	9.3	4	104	13
6/28	83	2	7.5	26	830	13
6/28	84	1	10.8	6	134	13
6/28	85	2	12.1	10	197	13
6/28	86	1	8.8	11	306	14
6/28	87	2	8	11	330	14
6/28	88	1	10.3	15	350	14

Appendix A.4. Sockeye salmon test-fishing data, Igushik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
6/28	89	2	11.3	16	345	14
6/29	90	1	12.3	23	451	13
6/29	91	2	11	14	305	13
6/29	92	1	11	18	392	13
6/29	93	2	10.5	10	252	13
6/29	94	1	13.3	5	91	13
6/29	95	2	13.3	5	91	13
6/29	96	1	6.3	50	1920	13
6/29	97	2	12.5	5	98	13
6/30	98	1	10.5	3	69	13
6/30	99	2	10.5	8	183	13
6/30	100	1	10.8	10	223	13
6/30	101	2	5	43	2064	13
6/30	102	1	8.5	52	1468	13
6/30	103	2	8.5	18	508	13
6/30	104	1	4.3	29	1685	13
6/30	105	2	6.3	25	960	13
7/1	106	1	12.5	0	0	14
7/1	107	2	7	12	411	14
7/1	108	1	12.8	11	205	14
7/1	109	2	4.3	22	1278	14
7/1	110	1	7.3	27	894	14
7/1	111	2	4.5	23	1221	14
7/1	112	1	8.8	36	986	14
7/1	113	2	8.5	19	535	14
7/2	114	1	10.5	5	114	14
7/2	115	2	9.3	10	260	14
7/2	116	1	11.5	3	156	14
7/2	117	2	4.8	62	3062	14
7/2	118	1	5.6	38	1658	14
7/2	119	2	7	33	1131	14
7/2	120	1	5.8	30	1277	14
7/2	121	2	8.5	10	282	14
7/3	122	1	10.5	8	183	15
7/3	123	2	9.8	31	762	15
7/3	124	1	9.5	12	303	15
7/3	125	2	5.3	26	1191	15
7/3	126	1	2.5	57	5472	15
7/3	127	2	2.3	58	6214	15
7/3	128	1	4.5	62	3292	15
7/3	129	2	2.5	42	4000	15
7/4	130	1	8.5	27	762	15
7/4	131	2	5.8	28	1191	15
7/4	132	1	6.5	25	920	15

Appendix A.4. Sockeye salmon test-fishing data, Igushik River, 1999.

Date	Set No.	Station	Mean Fishing Time(min)	Sockeye Catch	Test Fishing Index	Water Temp(C)
7/4	133	2	4.3	16	906	15
7/4	134	1	5.5	45	1957	15
7/4	135	2	3.3	72	5317	15
7/5	136	1	8.3	17	495	15
7/5	137	2	3	47	3760	15
7/5	138	1	5.3	27	1234	15
7/5	139	2	3.8	42	2681	15
7/6	140	1	3.8	39	2489	15
7/6	141	2	6.3	29	1115	15
7/6	142	1	5	65	3120	15
7/6	143	2	2.5	72	6912	15
7/7	144	1	6.8	30	1065	15
7/7	145	2	2.3	42	4480	15
7/7	146	1	6.3	27	1037	15
7/7	147	2	5.3	27	1234	15
7/8	148	1	10.5	26	594	15
7/8	149	2	4.8	41	2067	15

Appendix B.1. Kvichak River sockeye salmon test-fishing data, 1979 - 1999.

Year	Travel Time (d)	Cumulative Index	Last Date Fished	EPI[1]	Cumulative Tower Count	Date[2]	Data Reference
1979 [3]	2	21,901	6/29	243	5,330,532	7/1	Meacham (1980)
1980	2	106,315	7/9	174	18,508,524	7/11	Bue & Meacham (1981)
1981	2	20,813	7/1	83	1,723,506	7/13	Bue (1982)
1982	2	17,718	7/21	63	1,119,996	7/23	Bue (1984)
1983	2	13,234	7/12	216	2,853,198	7/14	Yuen (1985)
1984	3	45,584	7/12	222	10,111,152	7/15	Yuen et al. (1985)
1985 [4]	5	41,649	7/16	171	7,120,506	7/23	Bue et al. (1988)
1986	1	25,923	7/15	43	1,102,242	7/16	Yuen et al. (1988)
1987	2	55,881	7/14	106	5,945,994	7/16	Fried & Bue (1988a)
1988	1	38,743	7/17	104	4,045,500	7/18	Fried & Bue (1988b)
1989	2	58,044	7/16	141	8,163,918	7/18	Stratton et al (1990)
1990	3	44,794	7/15	149	6,673,872	7/18	Stratton (1990)
1991	2	56,669	7/17	71	4,114,932	7/19	Stratton & Woolington (1992)
1992	4	46,755	7/16	100	4,686,828	7/20	Stratton & Crawford (1994)
1993	1	47,449	7/20	84	4,007,712	7/21	Stratton & Crawford (1996)
1994	2	55,073	7/15	142	7,631,076	7/17	Gray et al (1999)
1995	2	62,556	7/18	154	9,702,972	7/20	Gray et al (1999)
1996	2	18,089	7/17	77	1,396,710	7/19	Gray et al (1999)
1997	2	25,228	7/16	58	1,434,504	7/18	Gray et al (1999)
1998	2	25,041	7/16	91	2,290,584	7/18	Gray et al (1999)
1999	4	73,725	7/16	85	6,266,625	7/20	Current report

[1] EPI value from travel time analysis on the final day of test fishing.

[2] Cumulative spawning escapement date is last date fished at test fishing site plus travel time to tower site.

[3] Sites used from 1979 - 1984 were located on west bank above Nakeen (site 1), and on east bank about 2 km above Sea Gull Flat Island.

[4] Data from 1985 to present may not be comparable with those from 1979 - 1984. Test fishing sites were relocated in 1985 about 20 km upriver from old sites, and changes were made in mesh size (from 13.65 cm to 12.7 cm) and in web material (from multifilament nylon to multistrand monofilament).

Appendix B.2. Egegik River sockeye salmon test-fishing data, 1979 - 1999.

Year	Travel Time (d)	Cumulative Index	Last Date Fished	EPI[1]	Cumulative Tower Coun	Date[2]	Data Reference
1979[3]	1	23,980	7/10	38	905,034	7/11	Meacham (1980)
1980	4	13,312	7/16	80	1,060,860	7/20	Bue & Meacham (1981)
1981	3	18,921	7/13	37	691,764	7/16	Bue (1982)
1982	3	30,361	7/12	34	1,029,684	7/15	Bue (1984)
1983	1	16,276	7/10	44	718,368	7/11	Yuen (1985)
1984	3	26,947	7/12	43	1,151,028	7/15	Yuen et al. (1985)
1985[4]	4	19,974	7/9	53	1,052,250	7/13	Bue et al. (1988)
1986	1	16,370	7/14	60	981,841	7/15	Yuen et al. (1988)
1987	2	21,810	7/14	53	1,162,464	7/16	Fried & Bue (1988a)
1988	1	21,024	7/16	76	1,591,752	7/17	Fried & Bue (1988b)
1989	3	30,343	7/12	52	1,590,234	7/15	Stratton et al (1990)
1990	3	17,578	7/16	123	2,155,062	7/19	Stratton (1990)
1991	4	31,066	7/12	88	2,722,476	7/16	Stratton & Woolington (1992)
1992	3	24,498	7/11	73	1,795,542	7/14	Stratton & Crawford (1994)
1993	1	17,189	7/10	78	1,346,160	7/11	Stratton & Crawford (1996)
1994	2	12,777	7/12	137	1,708,998	7/14	Gray et al (1999)
1995	2	11,769	7/12	100	1,139,724	7/14	Gray et al (1999)
1996	2	15,043	7/12	72	1,039,428	7/14	Gray et al (1999)
1997	2	20,136	7/12	52	1,051,500	7/14	Gray et al (1999)
1998	3	16,476	7/13	65	1,032,480	7/16	Gray et al (1999)
1999	5	20,568	7/13	82	1,686,576	7/18	Current report

[1] EPI value from travel time analysis on the final day of test fishing.

[2] Cumulative spawning escapement date is last date fished at test fishing site plus travel time to tower site.

[3] Sites used from 1979 - 1998 were located about 3 km upriver from tip of Egg Island on the south (site 1), and on the north bank (site 2).

[4] Data from 1985 to present may not be comparable with those from 1979 - 1984 because changes were made in gillnet mesh size (from 13.65cm to 13.02 cm) and in web material (from multifilament nylon to multistrand monofilament).

Appendix B.3. Ugashik River sockeye salmon test-fishing data, 1979 - 1999.

Year	Travel Time (d)	Cumulative Index	Last Date Fished	EPI[1]	Cumulative Tower Count	Date[2]	Data Reference
1979[3]	9	42,880	7/13	39	1,662,348	7/22	Meacham (1980)
1980	3	85,711	7/17	30	2,550,174	7/20	Bue & Meacham (1981)
1981[4]	3	73,861	7/16	18	1,304,022	7/19	Bue (1982)
1982[5]	4	48,057	7/15	23	1,120,680	7/19	Bue (1984)
1983	1	15,485	7/16	54	831,744	7/17	Yuen (1985)
1984	8	20,138	7/17	61	1,223,286	7/25	Yuen et al. (1985)
1985[6]	7	30,903	7/16	32	997,026	7/26	Bue et al. (1988)
1986	9	36,786	7/15	27	1,001,492	7/24	Yuen et al. (1988)
1987[7]	6	14,393	7/17	41	587,964	7/23	Fried & Bue (1988a)
1988	2	16,106	7/24	39	625,752	7/26	Fried & Bue (1988b)
1989	5	36,562	7/21	46	1,669,350	7/26	Stratton et al (1990)
1990	3	20,113	7/20	34	692,310	7/23	Stratton (1990)
1991	4	27,359	7/15	82	2,255,216	7/19	Stratton & Woolington (1992)
1992	2	21,601	7/18	92	1,997,058	7/20	Stratton & Crawford (1994)
1993	2	14,793	7/13	87	1,292,046	7/15	Stratton & Crawford (1996)
1994	1	8,180	7/17	94	766,638	7/18	Gray et al (1999)
1995	3	9,609	7/17	66	1,136,262	7/20	Gray et al (1999)
1996	2	18,617	7/18	36	610,926	7/20	Gray et al (1999)
1997	3	21,969	7/18	22	481,356	7/21	Gray et al (1999)
1998	2	8,243	7/18	71	589,920	7/20	Gray et al (1999)
1999	5	17,549	7/18	84	1,474,116	7/23	Current report

[1] EPI value from travel time analysis on the final day of test fishing.

[2] Cumulative spawning escapement date is last date fished at test fishing site plus travel time to tower site.

[3] Three sites used from 1979 - 1980 located about 1 km downriver from Ugashik Village on east bank (site 1), and on the west bank about 4 km and 5 km upriver from Ugashik Village (sites 2 & 3, respectively).

[4] Two sites used beginning 1981 located on east bank about 7 km upriver from Ugashik Village (site 1) and on west bank about 8 km upriver from Ugashik Village (site 2).

[5] Site 1 moved to east bank about 5 km upriver from Ugashik Village and Site 2 moved to west bank about 5 km upriver from Ugashik Village.

[6] Data from 1985 to present may not be comparable with those from 1979 - 1984 because changes were made in gillnet mesh size (from 13.65cm to 13.02 cm) and in web material (from multifilament nylon to multistrand monofilament).

[7] Site 1 moved to east bank about 8 km upriver from Ugashik Village and Site 2 moved to west bank about 8 km upriver from Ugashik Village.

Appendix B.4. Igushik River sockeye salmon test-fishing data, 1979 - 1999.

Year	Travel Time (d) [1]	Cumulative Index	Last Date Fished	EPI [2]	Cumulative Tower Count	Date [3]	Data Reference[4]
1979 [5]	2	45,013	7/13	17	787,542	7/15	Meacham (1980)
1980	4	38,673	7/15	50	1,945,758	7/19	Bue & Meacham (1981)
1981	4	37,975	7/14	14	532,896	7/18	Bue (1982)
1982	5	12,638	7/12	33	411,420	7/17	Bue (1984)
1983	4	15,322	7/13	11	161,754	7/17	Yuen (1985)
1984	3	25,743	7/14	6	162,054	7/17	Yuen et al. (1985)
1985 [6]	5	15,347	7/11	13	199,386	7/16	Bue et al. (1988)
1986	4	18,288	7/14	14	262,104	7/18	Yuen et al. (1988)
1987	5	6,609	7/14	21	138,186	7/19	Fried & Bue (1988a)
1988 [7]	2	6,186	7/13	26	160,446	7/15	Fried & Bue (1988b)
1989	1	11,802	7/8	25	296,658	7/9	Stratton et al (1990)
1990 [8]							
1991	3	7,431	7/15	97	721,314	7/18	Stratton & Woolington (1992)
1992	4	5,175	7/13	56	289,644	7/17	Stratton & Crawford (1994)
1993	6	511	7/11	760	388,512	7/17	Stratton & Crawford (1996)
1994	2	2,343	7/13	108	253,044	7/15	Gray et al (1999)
1995	2	3,609	7/8	105	378,945	7/10	Gray et al (1999)
1996	3	5,295	7/12	62	328,290	7/15	Gray et al (1999)
1997	3	10,543	7/14	12	126,516	7/17	Gray et al (1999)
1998	2	9,080	7/12	19	172,520	7/14	Gray et al (1999)
1999	2	16,994	7/8	19	322,886	7/10	Current report

[1] Estimates for 1979-83 based on correlation coefficients; estimates for 1984-99 based on travel time analysis.

[2] EPI value from travel time analysis on the final day of test fishing.

[3] Cumulative spawning escapement date is last date fished at test fishing site plus travel time to tower site.

[4] Weighted season mean length, weight, travel time, and EPI values for 1979-86 were recalculated for 1987 report (Fried and Bue 1988a), and may differ from those in original report.

[5] One site, located on south bank about 30 km upriver from district boundary, was used from 1977-84.

[6] Site 1 moved to south bank about 28 km upriver from district boundary and site 2 added on north bank about 27 km upriver from district boundary.

[7] Data from 1988 to present may not be comparable with those from 1979-87 because of changes in fishing method (drifting gill net rather than anchoring one end on shore).

[8] Igushik test fish project not operated in 1990 due to budget cuts.